The Pursuit of Precision in the Field Artillery

A Monograph
by
MAJ Manuel R. Garcia
United States Army

School of Advanced Military Studies
United States Army Command and General Staff College
Fort Leavenworth, Kansas

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Approved by:

__________________________________ Peter J. Schifferle, Ph.D.	Monograph Director
__________________________________ James M. Tennant, COL, SF	Monograph Reader
__________________________________ Stefan J. Banach, COL, IN	Director, School of Advanced Military Studies
__________________________________ Robert F. Baumann, Ph.D.	Director, Graduate Degree Programs

Abstract

THE PURSUIT OF PRECISION IN THE FIELD ARTILLERY by MAJ Manuel R. Garcia, 51 pgs.

Artillery has gone through two previous evolutions in employment methodology. The first, starting in 1670, saw it evolve from primarily a siege engine, to a precision mobile direct fire support platform. The second evolution in methodology began in 1865 and saw the precision mobile direct fire support platform evolve into a volume fire indirect fire support platform, which culminated in the Russo-Japanese War.

The thesis of this paper is that through a historical examination of the evolution of the method of employment during those two periods, this monograph proves that the arrival of precision munitions heralds the onset of another evolutionary employment method for the field artillery. This method will emphasize precision fires over indirect volume fire. In order for this evolution to occur, the field artillery community must avoid the same type of evolutionary stagnation that occurred after the American Civil War.

Each evolution saw improvements, of varying degrees, in four areas and Improvements in mobility, precision, target discrimination and communications all interacted to a varying degree to force change. These are used as the evaluation criteria for each period.

The author determined that when moving from siege to direct fire, only improvements in mobility and precision were needed to spark an evolutionary change in employment. This was because target discrimination and communications were facilitated by the weapons proximity to the target. When the method of employment moved beyond the direct fire mode to volume indirect fire, it took improvements in communications and target discrimination to spark a new method of employment.

Technology has improved the volume indirect fire method with weapon systems that are capable of self-location and self-calculation of firing data. Precision guided munitions such as the Guided Multiple Launch Rocket System and the Excalibur artillery round have effectively removed the errors that occur with long-range weapon systems. The modular brigade combat team does not take advantage of these advances in precision and typically has to rely on augmentation from fires brigades in order to obtain this new capability.

It is the recommendation of this paper that each brigade combat team has the organic capability to provide its own long-range precision fires. The Army can accomplish this by the replacement of two howitzers per battalion with two GMLRs capable launchers. The advantages of creating these hybrid battalions are two-fold. First, for training and planning purposes, each maneuver brigade will have its own organic non-line of sight precision fire support. Second, it will no longer be necessary to create ad-hoc precision fires platoons in order to provide this capability to the maneuver battalions, enhancing predictability for training and deployment.

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Introduction

Artillery has existed in some form or other since medieval times. Even with the advent of gunpowder, artillery was simply another tool of siege craft. Sieges being mainly static affairs, mobility was never a main concern. As the operational environment changed, so did the requirements for artillery. As the level of education and experience with artillerymen improved, so did innovation. Improvements in manufacturing lead to improvements with the artillery piece, greatly enhancing its mobility and precision. This newfound mobility and precision lead to an entirely new method of employment and subsequently culminated during the time of Napoleon in a direct fire method, which served as a model of employment for many years.

The thesis of this paper is that through a historical examination of the evolution of the method of employment during the siege and direct fire periods, this monograph proves that the arrival of precision munitions heralds the onset of another evolutionary employment method for the field artillery. This will be an evolution in method where communications and target acquisition, not mobility or precision, are the chief limiting factors on the full employment of the maneuver commander's mobile fire support systems. This evolution in method is not a foregone conclusion. For this evolution to occur, the U.S. Army must avoid the same historical pitfalls that stymied innovation in the past.

This forthcoming evolution is not a unique situation. Artillery has evolved into a new method of employment during two specific periods in the past four hundred years. In the first period, siege artillery adapted to a changing environment and went from use as a siege-breaking weapon in 1670 to a mobile direct fire support system. This employment method went through a period of refinement and culminated in the Napoleonic method in 1805. During the second period, the environment again adapted and the direct fire support system evolved into an indirect fire support system during the period 1865-1904 where it matured during the Russo-Japanese War of 1904.

The arrival of tactical surface-to-surface precision guided munitions to the current battlefield will establish the relevancy of the artillery branch to a level not seen since the time of Napoleon. The arrival of two weapon systems, the Guided Multiple Launch Rocket System, and the Excalibur artillery round and the promised delivery of a third, the Non Line of Site Launcher System, promises to bring a new era of relevancy to the field artillery community. By understanding the mobile application of precision firepower as a fundamental requirement for the field artillery, the reader can see that those same requirements from history continue to apply and today's technological improvements will meet those needs. By understanding the current need for the mobile application of precision firepower, one can understand if the field artillery is in a period of increasing technological efficiency or if it is on the cusp of an entirely new artillery employment model.

In 1962, Thomas S. Kuhn published *The Structure of Scientific Revolutions.* In it he attempted to discover how new and unexpected phenomena continued to occur when you had an existing paradigm.[1] The U.S. Army field artillery community is currently mired in a persistent conflict in two separate countries and sees itself stretched almost beyond its resources. Attempting to gain efficiencies in labor and material, it has pressed artillerymen to be everything from truck drivers, foreign army training team members, military policemen, to forward operating base security forces. There are artillery officers who have spent their entire initial career without ever having seen a gun line.[2] New artillery systems are being developed and fielded while at the

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[1] Discovery commenced with an awareness of an anomaly to the established paradigm. It would then continue with an examination of the anomaly. It would finally close with a new set of facts that demand more than an adjustment to the existing paradigm but instead demand an entirely new paradigm. When enough anomalies have accrued against a current paradigm, the paradigm is thrown into a state of crisis. See Thomas Kuhn, *The Structure of Scientific Revolutions*. (Chicago: University of Chicago Press, 2009), 53.

[2] Samuel White, "The Fires Brigade; A Critical Capability in an Era of Persistent Conflict," US Army Homepage, http://www.army.mil/professionalwriting/volumes/volume6/october_2008/10_08_4.html (accessed April 4, 2010).

same time, some legacy Cold-War era artillery systems such as the MLRS are entering their third decade of service and others are simply improvements on a fifty-year-old design (Paladin). This paper argues that in order to avoid the same type of issues that plagued the U.S. artillery during 1865-1904, it must whole-heartedly embrace the move from volume fires to precision fires.

The paper begins with an examination of the origins of the mobile precision fire support requirement and the steps that were needed to meet that requirement. The Napoleonic model is given as an example of the mature method for the employment of direct fire artillery. The paper will then examine why, after the American Civil War, this model was no longer effective. It gives examples of work done on the European continent to re-establish the artillery's relevance. The Russo-Japanese War of 1904 is given as an example of the maturation of the indirect fire model. Examples of technological advancement in the field artillery from 1904 to the present day demonstrate the persistence of the indirect fire model and the crisis in relevance that was presented by the arrival of nuclear weapons. The paper then examines the establishment of the Air-Land-Battle doctrine in 1976 and its effect of current weapons development and employment. It then culminates with the development and implementation of tactical precision guided munitions in the U.S. Army, their current employment in the contemporary operating environment and recommendations for maximizing the utility of the current weapon systems.

Excluded from this study were precision guided munitions delivered by the infantry, aviation, and unmanned aerial vehicle community as they were beyond the scope of this study.[3] To understand current artillery doctrine one has to examine the origin of the field artillery.

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[3] Also excluded were the developments in Coastal Artillery during the time as this paper is primarily concerned with the effects of increased precision and mobility on field artillery doctrine See Vardell E. Nesmith, "Stagnation and change in Military Thought: The Evolution of American Field Artillery Doctrine, 1861-1905, An Example" (MMAS Thesis, Command and General Staff College, 1976), 159.

Origin of Mobile Fire Support

Between 1670 and 1702, the French monarch Louis XIV had his superintendant of fortifications build over three hundred fortified and garrisoned strongholds. Artillery evolved to fill the role of siege-breaker because the maneuver commander had a very simple requirement for his cannon. Reduce the enemy's fortifications in the most expeditious way possible and do it in a manner that does not expose the friendly side to enemy fire. Foundries made siege cannons large and very heavy in order to fire a large shot and resist the catastrophic effects of a burst tube. Mobility was not a factor. Precision was a matter of hitting the large walls or towers of a castle or city wall. Target discrimination again was a not a problem. Communications were simple as well.[4] A static defense of a position with heavy fortification required a large siege engine that had limited mobility requirements. Precision required hitting the castle walls. Target discrimination and communications were non-issues as well due to the relatively short ranges. However, as cannon size increased, previously impregnable fortifications proved increasingly vulnerable to these siege cannon. [5]

The role of field artillery was limited during this time because it usually arrived too late on the scene of battle in order to play a decisive part. It was hard for the heavy guns of the time to keep up with the infantry in bad weather. Some commanders were able to mitigate these limitations on mobility using watercourses (rivers) but found themselves bound to those very same watercourses. Cavalry was still numerous but its role had diminished due to the increasing volume of fire coming from the infantry and the artillery.

Numerous commanders were pre-occupied with the idea of making their artillery more mobile. The most successful commander of the time was Gustavus Adolphus. Adolphus' "leather

[4] J. B. A. Bailey, *Field Artillery and Firepower* (Annapolis, Md.: Naval Institute Press, 2004), 162.

[5]Ibid, 6.

guns" fired a 3-lb ball, weighed less than 120 lbs and only required the use of two horses to drag them anywhere on the battlefield. [6] Although the concept of making artillery more mobile on the battlefield made sense, the cost of these artillery pieces limited their availability. Siege artillery was not an equal contributor on the battlefield because it could not deliver concentrations of fire in a critical time and space. The ability to deliver critically needed concentrations of fire would require technical modernization, greater mobility, more guns, and more specific doctrine on their roles during the conduct of battle.[7] Gustavus' cannon and their increased mobility had decisive effects on battlefields dominated by large linear battle formations. Enemy commanders faced a dilemma--adapt to this anomaly or succumb. [8]

Kuhn wrote, "awareness of anomaly plays a role in the emergence of new sorts of phenomena".[9] He describes how when enough anomalies have accrued against a current paradigm, the scientific discipline is thrown into a state of crisis. In addition, it is during this crisis that new ideas are tried. Eventually a new paradigm is formed, which gains its own new followers, and an intellectual battle takes place between the followers of the new paradigm and the holdouts of the old paradigm. [10]

The holdouts of the previous paradigm for the employment of artillery in support of maneuver warfare came face to face with the humiliating defeats of the French Army during the Seven Years War. These failures garnered a great deal of attention from European army officers. They wrote pamphlets and books and attempted to address the errors in tactics and recommend solutions, not all of them practical. However, some of the recommendations proved sound and

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[6] Bailey, *Firepower*, 163.

[7] Ibid, 164.

[8] Gunther Erich Rothenberg, *The Art of Warfare in the Age of Napoleon* (Bloomington: Indiana University Press, 1978), 22.

[9] Kuhn, *Revolutions*, 53.

[10] Ibid.

formed the foundations for the French Republican and Napoleonic Armies. The primary tactics debate was between the supporters of the deep column formation and those favoring the linear formation. [11]

Meeting the Mobile Precision Requirement

Guiberts' famous *Essai general de Tactique* proved to be the most important of all of the post Seven Year War doctrinal publications. Guibert favored a synthesis of column and line, the column for movement and the line for battle.[12] His main point was that mobility was more important. Battalions should be able to move from column to line and line to column rapidly. Guibert issued a drill book in 1788 and followed it with a definitive edition in 1791. Guibert's formations described in *Tactique* provided mixed bodies of infantry and artillery, which would march separately and would be strong enough to defend themselves while still maintaining the ability to concentrate into an army in order to fight the battle.[13]

Dutch improvements in artillery manufacture allowed the artillery to keep pace with the infantry and ensured the development of a combined arms approach to warfare. The drive to enhance the mobility of the artillery began in 1747 when the Dutch began to use new methods for the construction of cannon. Instead of casting the cannon as hollow tubes, manufacturers cast the tubes as one solid piece and then drilled them out to ensure uniformity. Windage (the amount of space between the shot and the tube walls) was reduced which allowed for the use of smaller charges. The precise method in which they drilled the tube allowed for a more accurate casting of the ammunition. Improvements in manufacturing techniques lead to a dramatic reduction in weight leading to an increase in the cannon's mobility. Smaller charges led to smaller combustion

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[11] Rothenberg, *Age of Napoleon*, 23.

[12] Ibid, 24.

[13] Basil Henry Liddell Hart, *The Ghost of Napoleon* (Westport, Conn.: Greenwood Press, 1980), 72.

pressure that lead to lighter tubes and gun carriages. The weight savings gained by these innovations did not create new siege cannon. Instead, the savings in weight allowed the artillerymen to employ these artillery pieces in an entirely new method. [14] This method promised to provide mobile but imprecise fire support on the battlefield. The quest for precision would have to wait.

Gribeauval brought the lesson in mobility back to France in 1763.[15] Jean Baptiste Vacquette de Gribeauval had gained experience in Austrian service under General director Prince Joseph Wenszel von Liechtenstein during the years 1756 to 1762. Liechtenstein had redesigned the Austrian field pieces based on the experience of the War of the Austrian succession. Due to this Austrian service Gribeauval was one of the men that understood what could be accomplished with a mobile fire support platform. Liechtenstein introduced a unified range of lighter three pounder, six pounder, and twelve pounder guns into the Austrian artillery.[16]

The advantage of this standardization was that it greatly reduced the logistics required to service guns in non-standard calibers, enhancing mobility. It also allowed the artillerymen to mass the effects of the new gun types, which marked the first move towards precision. Gribeauval stated, "In the present way of making war the artillery branch has progressed so far that it determines the fate of our arms and victory in defeat or battle."[17] Gribeauval advocated striking power and mobility with the result of his work being a range of four-pounder, eight-pounder, and twelve-pounder guns as well as a six-inch howitzer.[18] Gribeauval also introduced a series of innovations that aimed at improving the artillery's accuracy. He introduced an elevating screw to

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[14] Rothenberg, *Age of Napoleon*, 24.

[15]Philip J. Haythornwaite, *Austrian Specialist Troops of the Napoleonic Wars* (London: Osprey, 1990), 3.

[16] Rothenberg, *Age of Napoleon*, 24.

[17] Bailey, *Firepower*, 165.

[18] Robert S. Quimby, The Background of Napoleonic Warfare: The Theory of Military Tactics in Eighteenth-Century France (New York: AMS Press, 1968), 293.

adjust the guns range instead of a wedge, allowing for more precise ranging. Gribeauval also provided the gun crews with graduated rear sights.[19] The elevating screw and the rear sight were seen as the most significant improvements regarding cannon in two hundred years.[20]

The expansion of artillery in the eighteenth century was not due simply technical innovation but was instead a result of steady and systematic movement to standardize equipment, organization, and practice.[21] The improved rear sight, the screw, the standardized field pieces and ammunition required educated gunners. No longer just a guild, artillerymen continued to display a distinctive *esprit de corps* as belonging to a "scientific corps".[22] Unlike the bulk of the soldiers drilled to follow the basic orders of infantrymen, artillerymen required technical training. The growing professionalism in the artillery was reflected by the creation of the Dutch Artillery School in 1735 and the British Army's Academy of Engineering and Artillery in Woolwich in 1741.[23] On the eve of the French Revolution, enlisted men and officers shared classes and education. The changes in European artillery were driven by the social and political factors affecting European society during that time.[24] This education and training had the effect of increasing the precision of the guns by ensuring well-trained soldiers operated them.

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[19] Bailey, *Firepower*, 164.

[20] As one example of the gains provided by these new schools an officer from the English artillery school, Benjamin Robins, published *New Principles of Gunnery* that described the projected advantages that could be gained from an elongated artillery projectile, rifled cannon, and the effects of wind resistance on a projectiles trajectory. See Bruce McConachy, "The Roots of Artillery Doctrine: Napoleonic Artillery Tactics Reconsidered," *The Journal of Military History* 65, no. 3 (July, 2001): 617-40, http://www.reenactor.ru/ARH/PDF/McConachy.pdf (accessed April 3, 2010), 619.

[21] Bailey, *Firepower*, 164.

[22] Rothenberg, *Age of Napoleon,* 27.

[23] Bailey, *Firepower*, 165.

[24] Rothenberg, *Age of Napoleon*, 28.

Employing the Mature Direct Fire Model

It is important to describe the basic framework of what would become the persistent model for the direct fire employment of field artillery. Describing the basic framework allows the reader to understand Napoleon's four basic requirements for artillery. The first involved harassing the enemy's assembly areas. The second was to act as counter battery against the enemy's guns. The third involved massing all guns on a point in the enemy's lines in order to create an offensive opportunity. The fourth involved covering the maneuver commander's retreat should the attack prove unsuccessful.[25] Napoleon used precision for the first and second tasks, mobility and precision for the third task, and precision followed by mobility for his final task.

Hypothetically, on the report of his cavalry screen that the enemy was massed in his immediate vicinity, Napoleon would order the nearest major formation to make contact with the enemy and, at all costs, to pin the enemy in place. Pinning the enemy would provide a fixed point upon which the rest of Napoleon's army would maneuver. Which corps had engaged the enemy was of little importance since each corps was a mini-army with cavalry, infantry, and artillery and could hold against a superior force for over 24 hours.[26] Before these 24 hours had passed the nearest supporting corps would arrive on scene to provide support to the beleaguered corps. Napoleon's corps were able to do this because they were more mobile than the enemy commander's forces. The enemy commander would find himself involved in an escalating battle of attrition against an ever-increasing number of French troops. Napoleon would waste no time in pushing up his reserves in an attempt to gain the initiative, counting on the early commitment of the enemy commander's reserve forces. The commitment of the enemy reserve forces was

[25] David G. Chandler, *The Campaigns of Napoleon* (New York: Macmillan, 1966), 185.
[26] Chandler, *Napoleon*, 185.

accompanied by an ever-growing crescendo of muskets and artillery as Napoleon's forces moved in to more effectively pin and pare down the enemies forces.[27]

Meanwhile Napoleon's enveloping force would be moving towards a portion of the enemy commander's flank or rear. Napoleon's enveloping forces would typically be cavalry reserve with their own force of horse artillery or an uncommitted all-arms corps. The critical moment would come when the enveloping force would announce its arrival to the enemy commander's force by fire and shock. The enemy commander, no longer having any reserve forces, could only hope to answer this challenge by thinning the line closest to the enveloping force in order to meet this challenge on the flank. Napoleon was waiting for this "event". [28]

At Napoleon's signal, the massed batteries of the Guard Reserve dashed to the front at a gallop and unlimbered within 500 yards of the enemy, tearing a great hole in the enemy formations with canister.[29] The French reserve infantry columns would race forward with fixed bayonets accompanied by a mass charge of cavalry, which in turn would force the enemy infantry to form protective squares. When the enemy infantry formed into defensive squares, it reduced the number of muskets that the enemy commander could bring to bear on Napoleon's charging forces. Napoleon would then order forward batteries of horse artillery to blast these large immobile squares, further demoralizing and thinning the enemy's lines. Once Napoleon had made his breach, he considered the battle won. Nothing would be spared in the pursuit of the "event". [30] The American Civil War would demonstrate why Napoleon's artillery tactics would lose their effectiveness.

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[27] Ibid.

[28] Chandler, *Napoleon*, 185.

[29] Quimby, *Background*, 296.

[30] Chandler, *Napoleon*, 189.

The Environment Adapts

The advent of the minie' ball (a conical shaped rifle bullet slightly smaller than bore of the barrel) created a new reality for the artilleryman.[31] With an effective range of over six hundred meters, it could bring effective fire upon an artillery battery attempting to unlimber its guns.[32] Rifles were not a new idea and many commanders had used them in a limited fashion. However, the loss in total throw weight, (the amount of rounds sent downrange during a specific period due to the slowness of loading the older rifles) meant that any commander attempting to equip his formation with rifles operated at a loss of his total offensive capability. Before the advent of the minie' ball, a rifleman was required to ram the tightly fitting bullet down the barrel in order to ensure the rifling properly engaged the projectile. An opponent equipped with muskets and bayonets would sweep an enemy equipped with rifles off the field. The introduction of the minie' ball was an innovation that would make infantry the decisive arm of the army.[33]

As minie' ball rifles became the prominent weapon on the battlefield, soldiers adapted. Frontal attacks became so costly that commanders were forced to revise this practice. Soldiers increasingly sought concealment and cover from this murderous fire.[34] Trenches and field

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[31] Vardell E. Nesmith, "Stagnation and change in Military Thought: The Evolution of American Field Artillery Doctrine, 1861-1905, An Example": (MMAS Thesis, Command and General Staff College, 1976), 9.

[32] Nesmith, "Stagnation", 11.

[33] Gone was the requirement to ram the projectile down the barrel, as the mine' ball was slightly smaller than the bore of the barrel. Instead the mine' had a hollow base that, at the combustion of the powder, expanded to fill the rifle's grooves in order to provide a gas check seal and impart the spin that greatly improved its accuracy. The mine' ball came prepared in a paper cartridge with a pre-measured amount of black powder creating an entirely new weapon system. Weider History Group. "Weaponry: The Rifle-Musket and the Minie' Ball." HistoryNet.Com. Available from http://www.historynet.com/weaponry-the-rifle-musket-and-the-mini-ball.htm. Internet; accessed 20 March 2010.

[34] Nesmith, "Stagnation", 11.

fortification became necessary in order to survive the long range rapid and accurate rifle fire.[35] The effect of this new strategy was that artillerymen no longer had concentrated and visible targets which they could engage. Since it was not possible to engage hidden infantry with any sort of precision with the current weapon systems, artillerymen attempted to mitigate this by increasing both their volume of fire and the effectiveness of artillery shells.

The problem created by the trench was that the angle of impact of the round was too low to permit the shell to enter a trench. A parapet formed forward of the trench created enough of a slope to block the descending arc of the direct fire method.[36] If a trench were dug in a straight line, a shell that did happen to impact inside the trench would have a devastating effect upon the defenders. The solution to this was to dig the trench along a series of angles oriented towards the enemy. The series of angles had the effect of changing what had become a linear target into a series of smaller non-linear and dispersed targets.[37] The arrival of the minie' ball rifle and the use of the trench would create the first anomalies for the Napoleonic artillery paradigm.

At the beginning of the American Civil War, the U.S. Army field artillery consisted of a handful of batteries buried within infantry regiments. It still enjoyed the reputation it had formed during the war with Mexico over a decade earlier. The Napoleonic model of what artillery could do when massed against a waiting enemy was firm in every officer's mind but the minie' ball rifle had changed the equation. The artillery could not rush forward and tear holes in the enemy's lines. Frontal attacks were just as deadly for infantry due to the increased lethality of the rifle. Men sought what cover they could against the murderous fire. This decreased the artillery's

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[35] Dennis Mahan, A Complete Treatise on Field Fortification, With The General Outlines of Principles Regulating the Arrangement, the Attack, and the Defense of Permanent Works (New York: Greenwood Press, 1968), 17.

[36] Nesmith, "Stagnation", 47.

[37] A chance impact in a trench following this zigzag pattern had a self-correcting effect minimizing the effect of the round to those in the immediate vicinity of the impact instead of the maximum burst radius of the round. See Nesmith, "Stagnation", 48.

ability to discriminate targets. If the enemy did try to assault, the artillery was still murderously effective with its liberal use of canister. In supporting the offense, the artillery had lost its effectiveness due to its loss of effective fire. Target discrimination and communications were not issues because all engagements were done using line of sight. It was still effective in the counter battery role but the effect of the new battlefield was to blunt its usefulness as a decisive offensive weapon of war.[38] The impetus to rectify the crisis affecting the Napoleonic artillery model would disappear with the end of the American Civil War.

Lack of Crisis Equals Stagnation

When enough significant anomalies have accrued against a current paradigm, that paradigm is thrown into crisis. Though practitioners of the previous paradigm may lose faith in it, they do not renounce that which has lead them into the crisis.[39] This was the case in the post American Civil War era. In 1866, the War Department, in order to establish a permanent representation of the field artillery, established the Artillery Board.[40] The board was encouraged to take initiative and make recommendations and had the potential of being an effective voice for the Artillery within the War Department.

One of the Artillery Board's major accomplishments was the re-establishment of the Artillery School at Fort Monroe, Virginia in 1868. The school had operated during the 1820's and 1830's but was closed in 1835 in order to meet troop demands created by the Seminole war. [41] The lack of formal instruction for artillery officers had created an educational gap between

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[38] Ibid, 40.

[39] Kuhn, *Revolutions*, 77.

[40] David R. Klinger, "The Field Artillery Board," *Field Artillery Journal*, (September – October 1982): 13.

[41] Birkhimer, *Historical Sketch*, 124.

artillery officers in the United States and artillery officers in Europe. By establishing an artillery school, the U.S. Army would eliminate the gap created by the poorly trained officers.

After the War Department deactivated five field batteries in 1869, the U.S. Army sent four of the remaining batteries to Fort Riley, Kansas, to form the nexus of a new school of practical field artillery instruction.[42] Unfortunately, the War Department then closed the school after only a year because it decided the artillerymen were urgently needed on the frontier as infantry and cavalry. Years later, in 1884, First Lieutenant William E. Birkhimer wrote, “In a word, the field artillery school was strangled in its infancy. That which, if properly nurtured, gave promise of fair proportions, bringing strength, symmetry, and high order of excellence to the field artillery”.[43]

The War Department had created the artillery school as an independent command responsible only to the General-in-Chief in Washington. Second lieutenants and selected enlisted men were given a year of instruction before proceeding on to their first troop assignments. Instruction was comprehensive for officers including study in gunnery, mathematics, artillery construction, military engineering, and surveying. Students became familiar with branch organization and their duties during campaigns and sieges. Enlisted soldiers studied mathematics, history, geography, and the employment of artillery. Birkhimer stated that the hope was “the artillery arm may, in so far as its disjointed organization will permit, enter upon a career of professional efficiency honorable to itself and reflecting credit upon the country”. The Army concentrated on the professional education of its officers and soldiers seeing them as the core of a newly professional artillery arm. The education provided by the school was important but its

[42] Ibid, 138.

[43] Birkhimer, *Historical Sketch*, 139.

major contribution was as a focal point for artilleryman and their professional discussions.[44] However, the school was closed because of more pressing needs.

Before the U.S. Army had completely demobilized after the Civil War, it was being called upon to fight the Indian Wars in the West. The U.S. Government had signed a series of peace treaties involving a policy of moving Indians onto reservations in areas whites did not want for themselves. Unhappy with reservation life, many Indians rebelled and raided nearby white settlements. In order to stop the Indian raids, General William T. Sherman and Major General Philip H. Sheridan devised a winter campaign plan devised to drive the Indians back onto the reservation. Three columns commanded by Major Andrew W. Evans, Lieutenant Colonel Alfred Sully and Major Eugene A. Carr were to converge on the Indians.[45] Evans and Lieutenant Colonel George A. Custer, who succeeded Sully, demonstrated the value of the winter campaigning against the Indians. Evans and Custer were reluctant to employ field artillery because of the belief it restricted their mobility. Field artillery was unable to keep up with maneuver, a statement that echoed Gustavas Adolphus complaints with his siege cannon.

Part of Evans and Custer’s reluctance stemmed from the artillery tactics of that time. In view of the Army’s Civil War experiences, War Department manuals emphasized massing field artillery to attack troop formations, fortifications, and hostile batteries. Field artillery tactics modeled on a conventional battlefield were not designed to accommodate situations where mobility was more important than firepower.[46] The failure of the artillery did not meet the

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[44] The school’s primary emphasis was heavy weapons. Discounting the major difficulties experienced by the light artillery with the trench and the rifle, the Army had the tendency to rest on its achievements in the recently concluded Civil War. The permanent Artillery Board was disbanded after a year and the Artillery lost its voice in the War Department. See Birkhimer, *Historical Sketch*, 186.

[45] Boyd L. Dastrup, *King of Battle: A Branch History of the U.S. Army's Field Artillery* (Fort Monroe, Va.: Office of the Command Historian, U.S. Army Training and Doctrine Command, 1992), 124.

[46] Dastrup, *Branch History*, 124.

conditions for a crisis as defined by Kuhn whereas “that crisis is a necessary precondition for the emergence of novel theories”.[47] What Evans and Custer experienced was an anomaly on one of the four basic requirements for field artillery, mobility.

As the Indian campaigns of the 1870s and 1880s demonstrated, the challenge of moving artillery over rugged terrain restricted its use. Field artillery simply could not stay up with an enemy that refused to stand and fight. The Indian Wars caused the artilleryman’s skills to deteriorate. When employed, the Army only employed guns singly or in pairs since it was necessary to disperse the guns amongst the scattered units. [48] At times untrained infantry or cavalry operated the pieces while the Army detailed artillerymen as infantry or cavalry.[49] There was no permanent artillery board or artillery school to voice these concerns to the War Department. The War Department no longer had a single organization or system as the intellectual focal point to establish a shared vision for artillerymen. This is unfortunate, as this intellectual focal point could have driven the vision for the evolution of artillery technology and doctrine.

Conflict Spurs European Innovation

Even though the Army introduced some breechloaders during the Civil War, based upon their performance, artillery officers did not see any reason to abandon muzzle-loading artillery. The breechloaders had not demonstrated a rate of fire greater than that of the muzzleloaders. Not even the Austro-Prussian War of 1866 encouraged the War Department to adopt rifled breechloaders. However, technological developments paved the way for the new steel breechloaders.

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[47] Kuhn, *Revolutions*, 77.

[48] Birkhimer, *Historical Sketch*, 134.

[49] Ibid, 138.

The outcome of the Franco-Prussian War of 1870-71 convinced the American artillery officers to reassess the American Army's position in regards to breechloaders. After having difficulty with its artillery during the Austro-Prussian war, the Prussian army discarded all of its smoothbore artillery.[50] They adopted improved Krupp steel breechloaders that did not leak gas at the breech.[51] The Prussians also reviewed and revised their field artillery tactics.[52] By the wholesale introduction of improved breechloaders, the Prussians had rendered the idea of an artillery reserve obsolete. By abolishing the reserve and instead distributing the guns to the maneuver commanders, the Prussians had ensured that even though they had a smaller number of artillery pieces, those pieces they did have would be employed early and often. Using the increased rate of fire and range, the Prussians were able to place their pieces at the center of their corps line and target the entire battlefield.[53] This doctrinal evolution was only possible due to the technological improvements taking place in Europe at the time.

The perfection of the Siemens-Martin open-hearth method in the 1870s made possible even greater control over the quality of steel while at the same time enabling the manufacturer to cut costs. By using hot waste gases or gases from low-grade fuel to preheat air and fuel, the Siemens-Martin method was capable of yielding "strong, elastic, tough, erosion, and heat-resistant steel, making it even more desirable for gun tubes."[54] The new gun tubes and ranges provided by the new guns tubes drove developments in other areas as well.

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[50]Gordon Alexander Craig, *The Battle of Koniggratz: Prussia's Victory Over Austria, 1886* (Westport, Conn.: Greenwood Press, 1975), 18.

[51] GlobalSecurity.org, "Breech Loading Rifled Artillery," GlobalSecurity.org, http://www.globalsecurity.org/military/systems/ship/new-navy2.htm (accessed April 2, 2010).

[52] The artillery reserve, a mass of guns held back by the commander and directed by him, was used as a sort of artillery musket line. Greater number of guns massed on a single target overcame the shortcomings of smoothbore artillery and increased its maximum effective range. See Craig, *Koniggratz*, 18.

[53] Dastrup, *Branch History*, 125.

[54] Like the American breechloaders, the Prussian's steel breechloaders leaked gas at the breech and often exploded when fired. Austrian gun crews were better than their Prussian counterparts and

For years, artillerymen had to struggle with the fatiguing task of pushing the cannon back into battery after every shot. In order to solve this problem, Europeans had searched for an effective recoil system. In 1873, Rather than mount the gun directly to the carriage, Krupp used a cradle that allowed the tube to move backwards and forward.[55]. Other refinements to the recoil system included wheel brakes and trail spades as well as improved hydraulic cylinders and springs. Coupling wheel breaks, trail spades, and the recoil system improvements with fixed ammunition (projectile and powder charge were one unit), the artilleryman now had an artillery piece that was capable of firing three times faster than its smoothbore antecedent.[56] Solving the recoil problem allowed the introduction of optical sights. A stationary carriage did not inflict jolts upon sensitive sighting equipment. Eliminating the recoil problem on artillery pieces had created a weapon system of increased precision. This was because a properly emplaced gun maintained its sight picture, which greatly facilitated subsequent round adjustment. All of these improvements provided major advances in precision.

The introduction of smokeless powder further improved the precision of the artillery piece. Smoke from black powder obscured the battlefield upon firing, making subsequent shots chancy at best. In 1884, Paul Vieille developed nitrocellulose propellant for military use.[57]The slower burning propellant produced other benefits than a reduced smoke signature. The dirty, dangerous, tube fouling black powder was being replaced by a clean burning, more predictable,

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aggressive Austrian tactics had prevented the Prussian artillery from having a decisive effect upon the battlefield. See Dastrup, *Branch History*, 126.

[55] "Breech Loading Rifled Artillery." GlobalSecurity.org. http://www.globalsecurity.org/military/systems/ship/new-navy2.htm (accessed April 2, 2010).

[56] The gun tube was coupled to a hydraulic system, which was itself coupled to a recoil rod. The recoil rod was attached to a piston with openings that allowed oil to flow through them when the cannon was fired. A compressed spring inside the cylinder pushed the gun back into position was the recoil had stopped. See Dastrup, *Branch History*, 127.

[57] Alfred Noble of Sweden combined nitrocellulose and nitroglycerine and patented ballistite in 1884, which was subsequently named cordite. See Bernard Brodie, *From Crossbow to H-Bomb* (Bloomington Indiana University Press, 1973), 143.

more efficient propellant. The adoption of smokeless powder gained efficiency for the artillery piece but it was not revolutionary in and of itself.[58]

The evolution in recoil systems and propellants allowed European gun makers to produce tubes in the 1890s weighing only one thousand pounds yet capable of throwing fifteen to sixteen pound projectiles over eight thousand yards. Only two decades earlier, a breechloader of comparable weight was capable of throwing a twelve-pound shot only about four thousand yards.[59] The massive reduction in the gun's total weight greatly increased its mobility but did not immediately result in a new method of employment. Without a corresponding increase in the effectiveness of the artillery round, the weight savings were merely unrealized potential. Meanwhile, work on the explosive filler for the artillery shell continued.

There was no point in increasing the range of the field artillery if there is a corresponding loss in effectiveness due to errors in range. Through the work of Paul Vieille and his associate Emile Sara, the French learned to control picric acid, a highly explosive substance. By combining nitrocellulose and picric acid, the two researchers patented a substance called melinite.[60] The issue with black powder was that shells filled with it tended to explode into five or six large pieces. Shells filled with melinite shattered into about one thousand splinters with devastating

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[58] A higher peak pressure required a heavier breach and thicker combustion chamber. Smokeless powder had a relatively gradual increase in pressure, which allowed for lighter breech assemblies and longer tubes. The cordites slow burning rate meant the projectile was continually accelerated as it was pushed down the tube. In contrast, black powder burned so quickly that the projectile only accelerated for a short time in the tube. Black powder created all of its power immediately creating a higher initial peak pressure. See Frank E. Comparato, *Age of Great Guns: Cannon Kings and Cannoneers Who Forged the Firepower of Artillery* (Harrisburg, PA.: Stackpole, 1965), 85.

[59] A.B. Dyer, "Handbook for Light Artillery" (New York: John Wiley and Sons, 1896), 133.

[60] Germany invented dynamite in the 1870s but this proved too stable for the fuses in contemporary shells. Though the idea of an explosive being too stable for use is hard to understand, what was needed was a substance of decreased stability that could be used as shell filler. See Dastrup, *Branch History*, 128.

effects against exposed troops.[61] The greatly increased effects of the improved shells improved precision by mitigating errors inherent in the increased ranges. What was needed now was a method of aiming the guns that took maximum advantage of the improvements of range and effectiveness.

Primitive methods for the employment of indirect artillery fire had existed for years. Increased ranges and firepower encouraged artillery officers to develop effective methods to control indirect fire in order to protect their guns in defilade and engage targets beyond line of sight. In 1882, a Russian officer, Karl G. Guk, explained the basics of this system by describing the method of the compass, aim point, and observer.

> Essentially, the system involved laying the sight of one gun of a battery on an aiming point, such as a stake or steeple. Then the angle between that point, the gun (the apex), and the target was measured by the forward observer and was set off on the sight dial. The base piece and other guns, allowing for intervals, were then traversed the requisite degrees to bring them to bear on the target. Range was estimated and adjusted by the forward observer. If shells landed to the right or left of the target, the forward observer corrected the deflection.[62]

Using this system, modern artillery had arrived on the battlefield.

However, the missing piece was an effective method of communicating with the supported units. Hidden from view, artillery pieces could not see the other combat arms and could not see the threats evident to the maneuver commander. The change to the indirect fire method

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[61] Comparato, *Age of Great Guns*, 90.

[62] European artillery officers continued to prefer direct fire because it allowed them to attack the target more quickly and were less complicated. By the end of the 1890s, field artillery pieces were made of steel, had recoil systems, used smokeless powder, and threw metallic-cased cartridge ammunition up to eight thousand yards away. Artillery was still lacking the key piece that would allow it to continue to support the cavalry and the infantry, its initial cause for adoption during the time of Napoleon. See Dastrup, *Branch History*, 129.

required a mechanical means of communicating with the guns. This method would have to be devised and not be vulnerable to easy destruction or disruption in combat.[63]

However, the progress in European artillery development was not mirrored in the U.S. Army. Hampered by a lack of funds and a surplus of Civil War artillery and black powder, the War Department took several years before developing its first breechloader. Encouraged by the Chief of Ordnance, Colonel Stephen V. Benet (1874-1891), the Ordnance Department converted a 3-inch Ordnance rifle in 1878. The department cut the gun at the breech, added a Krupp breechblock, and rebored the gun to a 3.18 diameter to make use of existing rifled ammunition. It then mounted the converted gun to a steel carriage to withstand the increased stresses caused by the larger charges. Even though this was a convenient method for disposing of surplus Civil War equipment, the wrought iron pieces were not up to the manufacturing standards of the European steel breechloaders. Benet and the Light Artillery Board of 1881 encouraged the War Department to introduce steel breechloaders in order to keep pace with Europe and directed the Light Artillery Board to design a new steel breechloader. [64]

Introducing the 1885 field gun, steel carriages, and telescopic sights moved the U.S. artillery into the age of breechloader, yet the artillery parks were still dominated by Civil War guns. The state of the field artillery created cries for reform in the early 1890s. The War Department "tested steel carriages, smokeless powder, pneumatic and hydraulic recoil brakes, a metal cartridge case, high explosives to burst projectiles, and elevating, sighting, and traversing mechanisms for the 1885".[65] Although a great deal of effort went into the development of the 1885, it used separate loading ammunition, lacked a recoil system and used black powder for both

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[63] Hew Strachan, *European Armies and the Conduct of War* (New York: Taylor and Francis Group, 1983), 122.

[64] Kondrad F. Schreier, Jr., "The U.S. Army 3.2-inch Field Gun", *Military Collector and Historian*, (Fall 1972), 77.

[65] Dastrup, *Branch History*, 134.

propellant and bursting charge. In comparison, the European guns employed smokeless propellant, recoil systems, and used fixed ammunition.[66]

The Spanish American War caught the U.S. artillery underprepared. Thirty years of fighting the Indian Wars had greatly diminished the skills of the U.S. artillerymen and caused them to forget the lesson that the rifle could cut exposed artillerymen to pieces. The Spanish artillery used smokeless powder and recoiled field pieces. The American artillery used black powder and steel carriage pieces. With huge clouds of white smoke announcing every shot, the Spanish guns quickly engaged the American artillery. The lessons of the Spanish War showed the dangers of lagging behind potential competitors technologically. Recognizing this error, the U.S. Army worked to rectify this mistake by sending observers to the Russo-Japanese War of 1904.

Emergence of the Indirect Fire Method

On 8 February 1904, the Japanese navy launched a surprise attack on Port Arthur and the shore defenses of the Russian fleet. A few days later, the Japanese army landed in Korea and began a march north to the Yalu River with the Japanese Second and Fourth Armies landing on the Liaotung Peninsula. The Second Army sealed the landward approaches to Port Arthur with the Japanese Third Army taking over responsibility for reducing the Russian garrison. [67] The efficiency of both the Russian and Japanese artillery impressed the international observers and there was no question as to the new effect of centrally controlled and massed indirect fire.

The method for the control of the siege artillery surrounding Port Arthur was telephonic. One officer controlled all of the siege artillery. Maintaining contact with his observers and each siege artillery regiment, this one officer was able to assign objectives to subordinate commanders even specifying the fire orders to the battery commanders. The Japanese army had used

[66] Ibid, 137.

[67] Nesmith, “Stagnation”, 267.

telephones for many years. In 1890, the Japanese adopted telephones for coastal defense installations and in 1897, began to issue a field version of the device. [68] By 1904, the utility of the telephone for the centralized control of the field artillery had been thoroughly exercised in the Japanese Army.

Both the Japanese and Russians used new tactics in order to ensure the continued survival of the batteries of guns. Commanders that attempted to fire their cannons in the open or in direct line sight of the enemy saw their batteries quickly engaged with heavy losses. Because of this, the Russian and Japanese armies made extensive use of laying their guns indirectly and behind cover. Indirect lay was the method of choice. The most memorable lesson of the war was the ability of the Japanese to concentrate the fire of their artillery. Captain Carl Reichmann, an American observer remarked, "the long range of the modern gun permits of a concentration of fire on any desired point without change of position."[69] The Japanese were able to mass the effects of widely separated firing areas with their modern version of fire control. The United States had sent many observers to the Russo-Japanese War and each of the American officers reported their observations in detail to the War Department.[70]

Brigadier General John P. Story, the then Chief of Field Artillery, recognized the significance of the observers reports on the Japanese methods for the employment of field artillery. In Story's annual report, he criticized the antiquated organization of American artillery

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[68] Nesmith, "Stagnation", 271.

[69] This involved orienting the guns of a battery so that their barrels were parallel in a known azimuth and recording the angle from each gun to an aiming point(s). By determining the angle between a target and the known azimuth of the guns they could be laid in the horizontal plane, elevation laying was in principle unchanged once the distance from gun to target had been determine The Japanese had also created 1 to 20,000 scale maps of the area. Ruled with 1-centimeter squares, the Japanese were able to centrally direct fire by reference to specific grids. See *Reports of Military Observers Attached to the Armies in Manchuria During the Russo-Japanese War (1906-1907)* (Washington: U.S. G.P.O., 1906-1907), 272.

[70] Ibid, 273.

as well as the fact that there was not one single senior field grade officer in the artillery branch. President Theodore Roosevelt was himself impressed by the performance of both the Russian and Japanese artillery. President Roosevelt sent a note to the Secretary of War wanting to know what steps had been taken to develop the U.S. artillery.[71] General Story's reply was that he and the rest of the artillery officers had done nothing beyond "epistolary" efforts. President Roosevelt was less than satisfied with General Story's response.

Encouraged by Story and the performance of the Japanese field artillery during 1904-5, the War Department revamped is field artillery tactics. Hesitant to abandon direct fire, it standardized the aiming point method for indirect fire in 1905. Two years later the War Department wrote that hiding field guns was paramount and explained in *Drill and Regulation* (1907), "When not incompatible with the effective accomplishment of the duty to be performed, concealment from view is always to be sought."[72] By adopting direct fire and rearming the field artillery with the latest weapons, the War Department introduced technology and tactics that rivaled their European counterparts. Even so, the U.S. artillery still made provisions for direct fire as late as 1916 and were reluctant to make a clean break due to the difficulties in employing indirect fire.[73]

The use of artillery during First World War did not create trench warfare. It was the belief that frontal attacks could prevail in the face of modern infantry and artillery weapons. Artillery was used to attempt a break out of the stalemate created by trench warfare. Firepower was generated in many ways most directly by increasing the size of the guns. The First World

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[71] Letter, Secretary to the President to the Secretary of War, 9 January 1905, Records of the Adjutant Generals' Office, 1780's – 1917, No. 949387, Old Military Records Division, Record Group 94, National Archives, Washington D.C.; quoted in Nesmith, "Stagnation",276.

[72] *Drill Regulations For Field Artillery, United States Army* (provisional), 1908 (Washington: U.S. G.P.O., 1908), 71-73.

[73] Dastrup, *Branch History*, 149.

War saw the blurring of the lines that defined siege and foot artillery and instead saw medium and heavy guns handled as field pieces. After 1914, indirect fire became the norm and enabled the artillery to create Napoleonic concentrations of fire because the artilleryman was able to mass all artillery pieces within range of the target.[74] This new indirect method would remain unchanged for the next 90 years.

Following the First World War, various boards made recommendations for implementing the lessons learned from 1914-1918. However, from 1919-1939, a surplus of war materiel, pacifism, conservatism, and limited budgets for new technology retarded the rearming of the field artillery and the development of new tactics and techniques. The greatest debate to occupy the War Department was the decision to motorize or mechanize the field artillery.[75] Major General Robert M. Danford, Chief of Field Artillery (1938-1942) expressed his feelings in September of 1939 when he told Army War College students that the motor surpassed the horse in some situations while the horse was better in others. He stated "to discard him during peace in favor of the motor 100 percent is simply putting all our eggs in one basket, and is, in my judgment, an unsound policy". [76]

The army education system and its professional schools prevented the type of stagnation the affected the U.S. Army after the American Civil War. Three main threads appeared in professional journals: the nature of artillery and its battlefield effect, the lessons of the AEF artillery, and possible technical details for future support of the other arms. Directly or indirectly,

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[74] Bailey, *Firepower*, 269.

[75] Peter J. Schifferle, America's School for War: Fort Leavenworth, Officer Education, and Victory in World War II (Lawrence: Unversity Press of Kansas, 2010), 39.

[76] Conrad Lanza, "Forecast of Field Artillery Progress During the Next Five Years," *The Field Artillery Journal* 6 (November-December 1933): 508-13, http://sill-www.army.mil/famag/1933/NOV_DEC_1933/NOV_DEC_1933_FULL_EDITION.pdf (accessed April 18, 2010).

the principles of mobility, precision, target discrimination, communications were frequent subjects.[77]

After 1918, the M2 105mm howitzer, the M1 155mm gun in 1940, improved fuses, and the creation of fire direction centers were all significant changes in the U.S. Field Artillery.[78] In World War 2 these motorized field pieces, centralized and effective fire direction centers, radio equipped forward observers, and technological and organizational developments increased the artillery's ability to support other arms. By 1945, field artillery routinely massed fires to blunt enemy offensives, create holes in enemy defensive lines, or fix the enemy to allow the other arms to attack. The fire direction centers facilitated massed fires, and it was these massed fires that provided the precision needed to service targets. The motorization of the towed and self-propelled guns enhanced mobility. The U.S. artillery overcame the two limiting factors, target discrimination and communications through the use aerial and forward observers equipped with radios.[79] The indirect fire method had continued to gain efficiencies in mobility, precision, target discrimination, and communications. What would happen next would present it with a crisis of relevance.

A Crisis of Relevance

The arrival of nuclear weapons created a huge anomaly for the field artillery. Whereas the arrival of lighter cannon had facilitated the shift from siege to direct fire and the arrival of the minie' rifle ball had forced the shift from direct fire to indirect fire, nuclear weapons seemed to make the field artillery superfluous. Yet, doctrine evolves due to experimentation and adaptation of combat forces to meet the changing challenges of war.

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[77] Schifferle, *School For War*, 41.

[78] Dastrup, *Branch History*, 201.

[79] Bailey, *Firepower*, 309.

The post World War II evolution of doctrine was largely a paper exercise. After hostilities had ended, the active duty divisions were reduced from eighty-nine to only ten divisions. Between World War II and the Korean War budgetary constraints shrank ground forces to the point that they were largely hollow forces. The War Department Equipment Board in 1946 reported that future artillery pieces should be more mobile, that an artillery piece larger than the 240mm howitzer should be developed and that the Army should develop rockets and guided missiles to give the service an all-weather, long range fire support system when tactical air could not be employed. However, the end of the war lessened the rearmament emphasis and the board decided to focus on a few weapons.[80]

In 1950, the National Security Council recommended a strategy in National Security Council Resolution 68 (NSC68), which called for an increase in military muscle to contain the Soviet threat.[81] President Dwight D. Eisenhower had an issue with this call for expansion because he believed that economic growth was the key to the continued security of the United States. The loss of relevance for the standing army and the lack of emphasis was reminiscent of what the Army had experienced after the end of the American Civil War. President Eisenhower saw only a limited role for the Army in an atomic age. He believed the money being spent on ground forces would be better spent on new highways to facilitate the evacuation of cities in the event of a nuclear attack. [82] He also thought the Army would be needed to police cities to restore order after a nuclear assault. His belief in the Army's restricted role saw a corresponding reduction in budget and manpower.

This new nuclear environment saw the Army struggling to adjust to its new role. On April 19, 1954 Army Chief of Staff, General Matthew B. Ridgway, provided detailed guidance

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[80] Dastrup, *Branch History*, 245.

[81] Ibid, 245.

[82] Sherman Adams, *Firsthand Report*, (New York: Harper Brothers, 1961), 339.

for the Army to be more mobile and flexible. He wanted it capable of dispersing in order to discourage nuclear attacks.[83] General Ridgeway's views started a series of studies and reviews that worked to give the Army a sense of focus in a world that had started to doubt its relevance. As an example of this crisis of relevance in 1954, the Army Field Forces fielded the Atomic Field Army (AFTA-1) and in 1955 AFTA-1 was tested by the first Armored Division in the FOLLOW ME and BLUE BOLT exercises. Following the field trials the army tweaked the division's organizations and evaluated modified AFTA-1 divisions during exercise SAGE BRUSH. Even though the Army understood the need to economize, it still pursued work on guided missiles to deliver atomic warheads satisfying the requirement for a long-range all weather fire support system. President Eisenhower showed little interest in the effort and suggested the use of new tactical atomic weapons made it possible to thin out the existing ground units.[84] The pursuit for a more conventional flexible capability continued to drive the search for a new division design and the tactical artillery weapons were gradually abandoned.

Origin of the Precision Requirement

In the 1970s, a series of events led the Army to revisit its design concept. The money required to fund the Vietnam War had cost the Army a generation of force modernization and the post-Vietnam drawdown had left the Army as a hollow shell. The Warsaw Pact had continued in its efforts to modernize its ground forces. The tactical nuclear weapon advantage had become

[83] Glen R. Hawkins and James J. Carafano, "Prelude to Army XXI: U.S. Army Division Design Initiatives and Experiments 1917-1995," Federation of American Scientists, http://www.fas.org/man/dod-101/army/unit/docs/xxi/toc.htm (accessed May 3, 2010).

[84] Exercise SAGE BRUSH, conducted at Fort Polk, Louisiana, became the largest field trials held in the United States since World War II. It included 110,000 Army troops plus 40,000 Air Force personnel. The exercise scenario tested the divisions under conditions of simulated atomic war, covering 25 major areas and focusing on dispersion, communications and mobility. In the end the final test report did not recommend ATFA1, concluding the designs could not sustain high tempo, dispersed operations. Even before the tests had concluded, however, there were signs that senior leaders had soured on the concept of an Army designed to fight only in a general nuclear war. See Hawkins, *Prelude.*

more and more of an illusion due to the fears of nuclear escalation. The 1973 Yom Kippur War had demonstrated the lethality of modern conventional weapons. After the establishment of the Training and Doctrine Command in 1973 with General William E. DePuy as commander, the new command assumed all responsibility for force design. A 1975 analysis of current force designs found the U.S. Army inadequate to meet the Soviet threat in Europe. [85]

The 1973 Arab-Israeli War and the Israeli experience influenced General DePuy's writing from the time he arrived in TRADOC. Apparently, the Army's future was not in direct involvement in insurgencies like Vietnam but was instead in facing the Soviet threat in Western Europe. The 1973 war summed up the problems faced by NATO, which revolved around the forward defense on a high technology battlefield by an outnumbered force. [86] General DePuy's compilation of all of these experiments, his own personal experiences, and his study of conventional conflicts culminated in the 1976 edition of *FM 100-5*, which stated the Army's primary mission was "winning the land battle".[87]

Chapter eight of the 1976 *FM 100-5* states, "Modern battles are fought and won by air and land forces working together".[88] The 1976 *FM 100-5* describes how both the Army and Air Force deliver firepower against the enemy, kill tanks, collect intelligence, conduct reconnaissance, provide air defense, move troops and supplies, and jam radios and radar. FM 100-5 makes the point that neither the Army nor the Air Force can fulfill these functions either completely or by themselves. Improvements in the Air Forces technology increased its ability to

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[85] Bailey, *Firepower*, 399.

[86] Richard M. Swain, *Compiled Selected Papers of General William E. DePuy* (Fort Leavenworth: Combat Studies Institute, U.S. Army Command and General Staff College, 1994), 12.

[87] Department of the Army, *Field Manual 100-5, Operations* (Washington D.C.: U.S. Government Printing Office, 1977), i.

[88] Army, *FM 100-5*, 8-1.

provide fire support. Field artillery was the U.S. Army's principle fire support weapon, however, the value of artillery firepower had declined between 1945 and 1985.

The range, power, and accuracy of tank guns had improved greatly with automated fire control systems. The anti-tank bazooka had evolved into such weapons as the MILAN and TOW (Tube-Launched, Optically Tracked, Wire-Guided).[89] Infantrymen were now using Anti-Tank Guided Missiles (ATGMS) to engage tanks. While the introduction of the ATGMs did not create an anomaly at the level of the introduction of the minie' ball, it did leave the artillery community searching for its own solution.

The hitting power of the artillery high explosive shell had remained relatively unchanged since 1945 but armored targets had become faster and harder to kill. The need for the artillery to gain an anti-tank capability coincided with the development of the anti-tank guided missiles (ATGMS) and anti-tank artillery would satisfy the commander's requirement for a precision standoff tactical weapon. The Copperhead was the U.S. Army's attempt to make a 155-mm anti-tank artillery shell. Even though forward observers could use the Copperhead to engage specific targets on the battlefield, the line of sight observation and its semi-active laser seeker head limited the utility of the munition.[90] The Army still desired a new weapon with self-targeting capability in order to mitigate the Russian numerical superiority and restore the artillery's decisive effectiveness.

Prior to the arrival of precision guided munitions in the field artillery inventory, the greatest leap in technology was the ability for self-propelled artillery systems to compute their

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[89] Bailey, *Firepower*, 481.

[90] It entered service in Europe in 1984 and was capable of maneuvered flight towards a target that an observer designated with a laser from either a ground based or aerial designation system. The semi-active laser seeker head required laser designation all the way to the target and battlefield effects and obscuration could influence this laser. Although the idea of a guided artillery munition was revolutionary, its short range (17 kilometers) and rigid engagement requirements made it a munition of decreased utility. See Bailey, *Firepower*, 482.

own firing data and determine their own locations. The Multiple Launch Rocket System (MLRS 1981) and the M109 Howitzer Improvement Program (HIP 1994) brought a unique capability to the field artillery community. With its fully automated fire control computer, the MLRS is able to determine its own location, receive the targeting information from the fire direction center, and then aim itself. It has a three-man crew but, when fully loaded, only needs one crewmember to fire the launcher. [91] The Paladin program took a 1950's technology self propelled howitzer and provided it the capability to determine its own position on the ground and compute its own firing data. Using radios, it can communicate digitally with the fire direction center and calculate improved firing data using radar. It no longer required an aiming circle for indirect lay or wires for communication, moving beyond 90 years of artillery practice, greatly improving mobility, precision, and communications.[92] However, These technological achievements did not stop the artillery's quest for precision guided munitions.

Tactical Precision Guided Munitions

The current political restrictions of our contemporary operating environment is one where the new political realities for the employment of force no longer make the use of volume fires suitable by our forces in the field. These new political constraints make it no longer possible to rain dozens of artillery rounds on cities or thousands of bomblets on a mechanized force in the field. When the Air-Land-Battle doctrine was developed, expediency and not politics drove weapons employment considerations. The soldiers today typically find themselves in urban environments that require increased standards for target discrimination and precision.[93]

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[91] "MLRS Multiple Launch Rocket System, USA." Army-technology.com. Available from http://www.army-technology.com/projects/mlrs/. Internet; accessed 28 March 2010.

[92] "M109A6 Paladin Self-Propelled Howitzer," GlobalSecurity.org, http://www.globalsecurity.org/military/systems/ground/m109a6.htm (accessed April 19, 2010).

[93] Edith Lederer, "UN says international convention banning cluster bombs will enter into force on Aug.," Huffingtonpost, http://www.huffingtonpost.com/2010/02/17/un-ratifies-ban-on-cluste_n_465022.html (accessed April 23, 2010).

Precision munitions are being touted as the answer to what has been the Field Artillery's major shortcoming, support for the close fight. Today's artilleryman finds himself caught in a dilemma. Precision munitions only work with precise enemy locations. Even though history has taught us the value of massed artillery fire, artillerymen cannot ignore the effectiveness of precision munitions in both the Iraq and Afghanistan areas of operation. Today analysts both inside and outside the Pentagon are calling for a restructuring of the force that places overwhelming emphasis on precision-guided-munitions (PGMS).[94] Many observers are claiming that the basic nature of warfare itself has changed. They make this claim because the potential for civilian casualties has diminished and the logistical burden of delivering artillery munitions has been drastically reduced. The current push for the wholesale adoption of precision as a new paradigm for the field artillery community has its parallels in the effort to reestablish the field artillery as a relevant combat arm in the period of 1865-1898. [95]

As with the advances of field artillery effectiveness in the direct fire paradigm, precision munitions initially appeared to be an extrapolation of new technologies and not a new approach to warfare. It has become clear that there is something fundamentally different about this new class of weapons. Accuracy is no longer a fundamental of range but instead remains constant over the entire range of the munition. In theory, the new guided munitions should not miss the target. In practice, PGMs have a higher probability of hitting a target then a projectile that arrives on a purely ballistic trajectory. With these improved guidance systems, there is no limit on the effective range of the PGM weapon systems. Army artillerymen see precision munitions as a major step forward. Yet these steps forward to a precision doctrine are much like the model 1885 cannon in that they initially only sought increased efficiencies on the indirect fire method. To

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[94] Robert Mandel, "The Wartime Utility of Precision Versus Brute Force in Weaponry', *Armed Forces & Society*, Vol. 30, No. 2, (Winter 2004), 171

[95] Mandel, "Precision", 171.

understand that precision munitions are an emerging doctrine one has to understand the original purpose of the weapon systems employing them.

The MLRS started life as the U.S. Army's General Support Rocket System) program in the mid-1970s. In 1976, Concept Definition Study contracts were supplied to several companies and in 1977, Vought and Boeing were selected for competitive development.[96]The MLRS was a weapon system designed to be employed on the battlefields of Europe for the specific purpose of supporting Air-Land-Battle doctrine. Highly mobile, each launcher is capable of firing seven thousand, seven hundred and twenty eight grenades towards a specific area of the battlefield. The MLRS is still referred by its previous acronym, GSRS, as the "Grid Square Removal System" for its ability to saturate an area with bomblets. The Air-Land- Battle Doctrine's desire for a surface-to-surface delivered tactical precision guided munition had not been realized due to the fact that it was an area fire weapon with no self-targeting capability. [97]

In 1994, the U.S. Army initiated the Guided MLRS (GMLRS) Advanced Technology Demonstration (ATD) to develop a guided derivative of the M26 MLRS rocket (spin stabilized with a 32-kilometer range and armed with 644 M77 Dual-Purpose Improved Conventional Munitions). The M30 GMLRS rocket uses and IMU (Inertial Measurement Unit) and a GPS (Global Positioning System) receiver and has four small additional control fins in the nose. The M30 guided rocket was the DPICM version of the GMLRS and was intended to allow more

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[96] In December of 1979, GSRS was renamed MLRS. Vought subsequently was named as the prime contractor for further development and production. The MLRS launcher and its rockets were scheduled with an initial operating capability 1983. In the MLRS's initial configuration it was designed to fire twelve rockets to a maximum distance of over 30 kilometers. Each basic rocket carried 644 high explosive grenades for anti-personnel and light vehicle engagements. The Multiple Launch Rocket System is a mobile rocket launcher that can fire a variety of rockets from the MLRS Family of Munitions (MFOM) as well as the MGM-140 ATACMS guided missile family. See U.S. Army, Redstone Arsenal, 28 FEB 2010, available from http://www.redstone.army.mil/history/systems/MLRS.html; Internet; accessed 28 FEB 2010.

[97] "MLRS Multiple Launch Rocket System, USA." Army-technology.com. Available from http://www.army-technology.com/projects/mlrs/. Internet; accessed 28 March 2010.

precise targeting on the battlefield. [98] The M30 guided rocket was an incremental increase on the previous unguided rocket, however, it still delivered an area effect.

The delivery of the M31 rocket is what provided the potential for change in the employment of the MLRS. Instead of providing an area effect, the commander now had a munition that could target specific points on a three dimensional battlefield. The M31 is a variant of the M30 that in place of DPICM bomblets, it instead has a unitary warhead. Referred to as the "70km sniper round" the M31 has a 200lb High Explosive (HE) warhead for attacking point targets and provides a one round kill capability. [99] The M31 has three fuse settings for use against personnel in the open, lightly fortified bunkers, or lightly armored vehicles.[100] The M31 was initially created as an alternative to the M30 GMRLS (DPICM) but experience in Operation Iraqi Freedom showed that the 200lb warhead was ideal for attacking built up targets in urban areas.[101]

Following a Urgent Needs Statement from the U.S. Army, the first XM31 / M31 was delivered in May 2005 with field testing in Iraq beginning the following August. Four hundred and ninety eight XM31 rockets were delivered to the U.S. Army in 2005 with the M31 being fired operationally in September of that same year. Eight rockets were fired over a distance of 50 kilometers destroying two insurgent strongholds and killing forty-eight enemy insurgents.

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[98] GlobalSecurity.org, M26 Guided MLRS, 14 February 2010, available from http://www.globalsecurity.org/military/systems/munitions/m26.htm; Internet; accessed 28 February 2010.

[99] GlobalSecurity.org, M31 GMLRS Unitary, 14 February 2010, available from http://www.globalsecurity.org/military/systems/munitions/m31.htm; Internet; accessed 28 February 2010.

[100] The M31 is being upgraded with a new Tri-mode fuse allows airburst, point impact, and delay modes in order to enhance its penetrator capability. The proximity sensor for airburst mode is also further modifiable for three meter or ten meter height of burst function. See GlobalSecurity.org, GMLRS Unitary.

[101] Capable of attacking point targets, the small size of the warhead eliminated the collateral damage typical from Air Force delivered 500lb Joint Direct Attack Munitions (JDAMs). See Patrecia Hollis "2007 Surge of Ground Forces in Iraq; Risks, Challenges and Successes." *Fires, A Joint Professional Bulletin for US Field and Air Defense Artillerymen* March-April 08 (March-April 2008): 9.

Following the mission, Colonel H.R. McMaster commander of the 3d Armored Calvary Regiment, made the statement, "The GMLRS Guided Multiple Launch Rocket System proved itself in combat in Tal Afar and provided the regiment with tremendous capability. It not only was able to hit enemy positions with a great deal of precision, but was able to limit collateral damage”.[102]

Previous to the arrival of the GMLRS, MLRS launchers had been left behind in staging areas in Kuwait or were not even brought over from their posts in the United States. As of 5 March 2009, The Army and the Marines had fired over 1,124 total rockets in support of operations. Over 648 rounds were fired in support of the U.S. Army, 27 rounds in support of the United States Marine Corps, and 449 rounds in support of the United Kingdom. In theater requests for the GMLRS came from the following organizations: 65% were at the request of the Army, 19% were in support of the Marines, with another 16% used to support other missions. Pre-planned targets take up 72% of all missions with troops in contact taking up 28%. The most compelling piece of data is that 96% of the missions were in support of Urban / COIN type missions.[103] This shift in employment demonstrated that field artillery had gained relevance and the weapon of choice for prosecuting either pre-planned or time sensitive targets.

Curiously, this increase in employment of the GMLRS has come at the expense of the employment of the Army Tactical Missile System. The Army Tactical Missile System Block IA Unitary (ATACMS) is a theater short-range ballistic missile launched from the M270 MLRS and the High-Mobility Artillery Rocket System (HIMARS) artillery systems. The ATACMS Block

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[102] The Free Library, New Guided MLRS Unitary Rocket is immediate success in Iraq, 7 April 2006, available from http://www.thefreelibrary.com/Department+of+Defense+news+release+%28April+7,+2006%29:+new+Guided+MLRS...-a0148756176; Internet; accessed 28 February 2010.

[103] Defense Technical Information Center, Precision Fires Rocket and Missile Systems, 11 March 2009, available from http://www.dtic.mil/ndia/2009psa_mar/Rice.pdf; Internet; accessed 28 February 2010.

IA Unitary is specially suited to attack high payoff, time sensitive targets.[104] The high cost of the weapon system ($500,000) meant that release control was seldom delegated below division commanders. [105] One weapon that was designed to be available to the maneuver commander was the Excalibur.

The U.S. Army considered the Excalibur 155mm Precision Guided Extended Range Artillery Projectile (M982 Extended Range Dual Purpose Improved Conventional Munitions) a fire and forget munition. The M982s accuracy and effectiveness was designed to reduce the logistical burden for deployed ground forces. The U.S. Army intended to use the M982 in the now cancelled 52-caliber XM2001 Crusader self-propelled howitzer. [106] While the Crusader was in development, the M982 was intended for use on existing weapons platforms such as the M109 self-propelled howitzer and the M198 towed howitzer. The cancellation of the Crusader turned

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[104] The Unitary Block IA retains the guidance system and maximum range of the Block IA missile but has had the M74 submunitions, also known as Anti-Personnel / Anti-Material (APAMs) replaced with a 500lb unitary warhead. The ATACMS Quick Reaction Unitary (QRU) can strike within meters of targets between 70 kilometers and 270 kilometers with a speed approaching mach 3. See Deagel.com, ATACMS Block IA Unitary, 1 March 2010, available from http://www.deagel.com/Ballistic-Missiles/ATACMS-Block-IA-Unitary_a001106003.aspx; Internet; accessed 1 March 2010.

[105]The precision and speed of the ATACMS QRU results in a strike that is nearly undetectable against targets that would flee or hide upon the approach of aircraft. The extreme range afforded by ATACMs Unitary allows the weapon system to operate in direct support of a maneuver commander from already secured airfields or beachheads. See SILL-WWW.ARMY.MIL, Fires Bulletin March-April 2008, available from http://sill-www.army.mil/firesbulletin/2008/Mar_Apr_2008/Mar_Apr_2008_pages_35_37.pdf; Internet; accessed 1 March 2010.Ibid.

[106] The M982s concentrated fragmentation pattern and near vertical descent would also provide lower risks of collateral damage. The M982 is part of a family of "precision-guided, extended-range modular projectiles incorporating three unique payload capabilities divided into Block configuration." Block I consists of a high-explosive fragmentary warhead. Block II consists of smart munitions to search, engage, and attack moving or short dwell targets. Block III consists of munitions capable of discriminating munitions to "selectively identify and engage individual vehicular targets in urban environments by distinguishing specific target characteristics." See GlobalSecurity.org, XM982 Excalibur Precision Guided Extended Range Artillery Projectile, available from http://www.globalsecurity.org/military/systems/munitions/m982-155.htm; Internet; accessed 1 March 2010.

focus of the M982 project designers towards the Non Line of Sight – Cannon (NLOS-C) of the Future Combat Systems (FCS) program. The NLOS-C would be in addition to the M109-A6 self-propelled howitzer, the M198 towed howitzer, and the planned XM777 towed howitzer that was brought in after the Crusader cancellation.[107] The NLOS-C's future is now in doubt with the cancellation of the Army's Future Combats Systems program.[108]

The Sense and Destroy Armor Munition (SADARM) is interesting as it is the only currently available artillery munition that is capable of answering the requirement for an artillery delivered ATGM as mentioned the 1976 FM 100-5. Designed to attack and kill lightly armored vehicles. SADARM is dispensed from a 155-millimeter (mm) howitzer round. Each howitzer round delivers two SADARM submunitions. Once dispensed, the submunition deploys a parachute-like deceleration device and searches for a target using millimeter wave radar. It is a true fire-and-forget weapon system with autonomous targeting capability and, while used during the initial invasion of Iraq in 2003, it has seen little use since then.[109]

The weapon system that answers all of the requirements for the evolvement of the volume indirect fire model to one of precision strike is the Non-Line-of-Sight Launch System (NLOS-LS). NLOS-LS is a concept for a vertical launch set of missiles with a command and

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[107]I GlobalSecurity.org, XM982 Excalibur Precision Guided Extended Range Artillery Projectile, available from http://www.globalsecurity.org/military/systems/munitions/m982-155.htm; Internet; accessed 1 March 2010..

[108] "US Army's Future Combat System (FCS) Program Cancelled," Deagel.com, http://www.deagel.com/news/US-Armys-Future-Combat-System-FCS-Program-Cancelled_n000006236.aspx (accessed April 14, 2010).

[109] At a predetermined distance from the ground, the submunition ejects the deceleration device and deploys another device to stabilize and rotate the submunition. As the submunition falls and rotates, the device searches the ground with a millimeter wave sensor and an infrared sensor array. Using the two sensors and detection logic, the submunition is designed to detect counter measured targets in a variety of climates. If the sensor detects a target, the submunition fires an explosively formed penetrator (EFP) at the target. If no target is detected the submunition is designed to self-destruct. See GlobalSecurity.org. "M898 SADARM (Sense and Destroy Armor)." GlobalSecurity.org. Available from http://www.globalsecurity.org/military/systems/munitions/sadarm.htm. Internet; accessed 30 March 2010.

control system in a box. It is designed to be platform-independent with each round in each launch container being an independent entity. The design is a box with sixteen sections, fifteen of which hold rockets with the last container holding the command and control gear. The vertical launch enables the system to engage targets in three hundred and sixty degrees. The missile has an onboard data-link with a dual mode seeker head allowing self-guidance or terminal seeker guidance by a forward observer. [110]

Not yet available to forces in the field the NLOS-LS, due to its data link allowing target updates from the observer and its laser seeker head, is the only artillery precision munition that satisfies the original requirements of the Air-Land-Battle doctrine and the current Full Spectrum Operations. [111] It meets the requirement of mobility with its low weight and air transportability. It meets the precision requirement with its capability of receiving target updates from the observer while in flight. It answers the communications requirement, as the observer is able to communicate with the round while it is in its launcher and throughout its flight to the target, and either the forward observer or the target seeker head in the munition provide target discrimination. However, this unique weapon system is still in development and the Crusader and NLOS-LC programs demonstrate that its adoption in a post conflict environment is not certain.

What started as an initial requirement under Air-Land-Battle doctrine for a surface-to-surface precision munition for destroying Soviet tanks culminated in five separate and distinct precision munitions. The copperhead had true precision due to its laser seeker head but was hampered by its limited range. The SADARM also had true precision and was successful during

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[110] Raytheon. "Raytheon Non-Line of Sight - Launch System (NLOS-LS)." Raytheon. Available from http://www.raytheon.com/capabilities/rtnwcm/groups/rms/documents/content/rtn_rms_ps_nlos_datasheet.pdf. Internet; accessed 29 March 2010.

[111] Department of the Army, *Field Manual 3-0, Operations* (Washington D.C.: Department of the Army, 2008), 3-1.

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the initial invasion of Iraq in 2003 but is limited by its inability to be used in proximity to friendly forces. The Excalibur has range and precision. The GMLRS has range and precision and carries a heavier payload than the Excalibur. In addition, the future NLOS-LS has range, precision, target discrimination, and communications. They all represent fundamental increases in weapons effectiveness.

Conclusion

The claim that the U.S. Army Field Artillery community is facing a period of doctrinal evolution due to the arrival of precision guided munitions is true based upon the examination of the historical model and the efficiencies gained by the new weapon systems. The evolution from siege to direct fire was due to improvements in mobility, precision, and to a lesser extent target discrimination and communications. The evolution of the direct fire paradigm to one of indirect fire involved those same principles. The technological evolution of the tubes, recoil systems, smokeless powder, shell filler, aiming devices, and command and signal technology all converged to create a new method of employment for an old concept. This concept was one that allowed the maneuver commander to rain fire down on his opponent in a manner that provided a decisive effect upon the battlefield.

Artillery precision is no longer a function of range for today's field artillerymen. An infantryman with proper communications and target location capabilities can be said, when in range of today's artillerymen, to carry the entire fire support capacity around in his pocket. The major constraint on today's soldiers is the ability to communicate over vast ranges and to discriminate targets with the degree of confidence required by a weapon system that can target at one-meter precision. This ability to locate and communicate is the greatest challenge for the U.S. Army and the ability to solve these challenges and provide practical solutions to the soldiers is the major test for the U.S. field artillery.

The United States field artillery has and always will be defined by its ability to deliver needed fire support on time and on target. Almost 350 years have passed since Gustavus Adolphus created his mobile fire support system and since that time, artillery has continued to improve in mobility, precision, target discrimination, and communications. The precise application of fire support from a system that has the mobility to support the maneuver commander is what defined the root requirement for the field artillery in Guibert's *Essai General de Tactique.* [112] Napoleon took those lessons learned by the artillerymen and created a modern method for the employment of fire support. Artillery had gained importance as a method to hit the enemy at ranges and with greater weight of fire than infantry or cavalry could achieve.

Napoleon's lessons were so powerful to U.S. Army officers that when challenged by the arrival of the minie' ball rifle, they did not know how to react. After, the American Civil War the U.S. Field Artillery failed to evolve effectively. The Indian Wars of 1870 saw artillerymen used as infantry, cavalry or as teamsters, something that resonates with today's artillerymen. The War Department starved the Artillery School at Fort Riley for funds. During the Indian Wars, the Army was more concerned with putting down Indian uprisings in the West than maintaining is proficiency as a modern fighting force. Replace Indian uprisings with occupations in Iraq and Afghanistan and the same Congressional reports could be used today to describe the current state of the U.S. field artillery. Lack of external interests and immediate rivals in the 19th century contributed to this complacency. It took the war with Spain to bring home the realization that there was a huge technological gap between the U.S. Army and its European counterparts. The lessons learned in the Russo-Japanese War by American observers hammered home that point.

The modernization of the field artillery in the past was driven by political, social, economic, and physical realities. The technological advancements were not simply gaining efficiencies but were instead enabling an entire new method for the employment of field artillery.

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[112] Hart, *Ghost*, 72.

First was the evolution from siege artillery to field artillery. Then the forced evolution of direct fire artillery to indirect fire artillery was due to the real world constraint imposed by the rifle. The arrival of the physical reality of tactically available precision guided munitions is forcing another evolution in the employment of field artillery.

Recommendations

In order to hasten the arrival of the precision strike paradigm, the U.S. Army needs robust precision strike batteries that are capable of providing organic long-range precision fires at all ranges and in a manner that facilitates long duration operations. There will be an increasing trend to deploy joint task forces precisely tailored for future missions and to command them with appropriate headquarters. There will less likelihood of deploying divisions and corps simply because the headquarters exist.

The typical artillery battalion has been optimized for use on a high intensity conflict battlefield and less so for persistent operations in a contemporary operating environment. Add in the requirement to for coverage twenty-four hours a day, seven days a week in order to provide precision fires and the current command and control structures of the field artillery battalions are understaffed. While it is possible to rotate guns through a hot, warm, and cold status (weapon manned, weapon maintenance, crew at rest) the command and control element (fire direction center) is not able to use that option. Mobile and precise fire support systems that are capable of target discrimination and communications throughout the range of the weapons systems require a robust command and control element.

The Platoon Fire Direction Center is forced to establish a day and night shift with the Fire Direction Officer (FDO) and Chief of Computer (CoC) splitting shifts. While this is workable in the short term, should either the FDO or CoC be unavailable, the unit typically has to cannibalize another position in order to fill in the shortage. Increasing the manning of firing batteries by an

additional FDO and CoC would give the unit the ability to organically address this shortcoming or, if needed, establish a third fire direction center. This would be advantageous in such operating environments such as Iraq or Afghanistan or in any future operation that sees guns operating singly or in pairs. This robust command and control capability needs a corresponding adjustment in the task organizations of brigade combat team field artillery battalions.

Today's modular Brigade Combat Team (BCT) centric army is more lethal, agile and deployable. The MLRS battalion is only modular in that it has a Forward Support Company (FSC) to support it while in theater. The battalion still has three batteries of six launchers each and deploys as a battalion consisting of 539 personnel and 242 combat vehicles. This is a significant footprint. Used typically in a General Support or General Support-Reinforcing (GS/R) relationship with the maneuver commander it now has the capability of supporting troops in contact. Looking at the Napoleonic model, keeping an artillery force in reserve in order to influence the battlefield makes sense when conducting high intensity conflict but it makes less sense when those artillery pieces could organically enhance the fire support of those same BCT commanders. Training would no longer be an issue as these launchers would deploy with the maneuver battalions and brigade during all training opportunities with no potential for scheduling conflicts due to competing real world commitments.

Instead of stripping Fires Brigades to create deployment packages, it would make more sense in today's contemporary operating environment to push those launchers down to the maneuver brigade's field artillery battalion. This would provide the field artillery battalion commander the ability to provide long-range precision fires. By replacing two howitzers out of the six howitzers in each battery with launchers, the BCT field artillery battalion would still maintain the capability to provide volume and close in fires as needed and gain the ability to reach out to ranges of 70 kilometers. This would effectively increase his operational reach by a factor of 233 percent while only diminishing his volume fire capability by 33 percent. Being organically available, these launchers would now be included in all layers of planning as well as

providing an immediate option for counter fire and requests for support from forces in the field. Tailoring the military occupational specialties of the BCT Forward Support Company there would be no issues with maintenance and logistics.

Units equipped with the 105mm M119A2 howitzers could benefit from the same type of hybrid employment by using two options. By waiting for the fielding of the NLOS-LS the battery would gain a 110 percent increase in its operational reach while losing only 33% of its volume fire throw weight (2 howitzers). Alternatively, it could attempt the same type of hybrid organization using a GMLRS capable launcher.

The U.S. Army can ensure that its requirement for organically available, beyond line-of-sight, surface to surface precision fires will always be available to the maneuver commander. It can do this by making the necessary changes to the task organizations of the field artillery batteries and battalions, ensuring that this capability becomes an integral part of every maneuver brigade commander's tactical approach for years to come.

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